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COMMENTARY

ANALYZING DERIVED STIMULUS RELATIONS REQUIRES MORE THAN THE CONCEPT OF STIMULUS CLASS

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The study of derived stimulus relations has led to new and exciting perspectives on the nature of human verbal behavior (Barnes, 1994; Horne & Lowe, 1996; Sidman, 1994) that go beyond traditional perspectives on the topic within behavior analysis. There is a great deal of conceptual and empirical work to be done, however, to compare and contrast the different approaches being taken by behavior analysts to analyze derived stimulus relations. Our purpose in the present paper is to contrast the emphasis of relational frame theory on the concept of stimulus relation (Barnes & Holmes, 1991; Hayes, 1991, 1994; Hayes & Hayes, 1989, 1992; Hayes & Wilson, 1996) with what we see to be a basic commonality between Sidman and Horne and Lowe: the centrality of the concept of stimulus class.

The concept of stimulus class has played a successful role in behavior-analytic interpretations of many phenomena, so it is not the utility of this concept in general that we wish to question. Rather, we wish to argue that (a) there are important differences between stimulus classes and stimulus relations, (b) popular research methods do not encourage clarity about this distinction, and (c) the attempt to interpret all derived stimulus relations in terms of the stimulus classes that may result is unnecessarily narrow and limits behavioral approaches to the analysis of language and thinking. Finally, we will suggest methodological alternatives that properly focus attention on the need for relational concepts in the analysis of derived stimulus relations.

The Dominance of Stimulus Class

Stimulus classes control common sets of responses because of either physical or functional similarity among a range of stimuli (Donahoe & Palmer, 1994). Class formation can be both a product and a process. For example, stimulus generalization—a term for stimulus class formation based on physical similarity—is universally recognized as a basic behavioral process. Similarly, operant contingencies give rise to functional stimulus classes as products.

This tendency to use class concepts both as products and processes has confused the analysis of derived stimulus relations. By definition, equivalence relations always give rise to stimulus classes as products. The various forms of mutual substitutability of stimuli in equivalence relations (reflexivity, symmetry, and transitivity) are considered by most to be the defining features of the particular class concept called *equivalence classes.* If class formation is also taken to be a process, however, then equivalence classes seemingly require no further explanation, and usually none has been provided. To Horne and Lowe's (1996) credit, they have attempted to go beyond this tautology, but their focus on stimulus classes as the issue is still unequivocal.

The emphasis on class concepts is partly methodological. The matching-to-sample procedure, which has dominated the study of derived stimulus relations, has characteristics that make class-based analyses likely. The re-

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sponse is picking or pointing to a stimulus given another stimulus. If this very performance is taken to be conclusive evidence that the two stimuli involved are in a class, then it is not possible to have consistent performances in a matching-to-sample procedure and *not* have stimulus classes. Because of this methodological characteristic, when matching-to-sample performances are unusual or complex, class-based analyses can always be maintained merely by supposing that there are multiple classes under contextual control. As we will show, this solution seems parsimonious until multiple types of stimulus relations enter the picture. Both Horne and Lowe and Sidman have so far not examined how unwieldy class-based theorizing must become under these circumstances.

The Challenge of Multiple Stimulus Relations and the Transformation of Functions

Several researchers have now demonstrated contextually controlled, arbitrary matching-to-sample responding in accordance with multiple stimulus relations such as same, different, opposite, or more than/less than (e.g., Dymond & Barnes, 1995; Steele & Hayes, 1991). The usual procedure involves pretraining with nonarbitrary stimulus sets to establish contextual cues for specific types of stimulus relations, followed by arbitrary matching to sample using these cues. Extraordinarily complex patterns of performances can result from this simple preparation. For example, Steele and Hayes showed that when subjects are trained to pick B3 given A1 in the presence of an OPPOSITE cue (for clarity, in this paper relational cues will be capitalized; in the actual study these cues were nonsense graphical forms), and C3 given A1 and OPPOSITE, they *avoid* C3 given B3 and OPPOSITE, but pick C3 given B3 and SAME. If subjects are also taught to pick D1 given C3 and OPPOSITE, they now pick D1 given C3 and OPPOSITE, but avoid it given SAME. How are such results handled, especially as more and more complex and nonsymmetrical relations (e.g., more than/less than; before/after) are added to the mix?

Sidman's Answer: Contextually Controlled Equivalence Classes

It is possible to maintain a class-based account of such results. The only place Sidman directly addressed the issue of multiple stimulus relations shows the steps that need to be taken. According to Sidman, "the fact that a stimulus pair can be brought via contextual control into such differing relations as same, opposite, different, and so forth, can be handled by any formulation of equivalence that recognizes the role of context" (1994, p. 561).

This statement shows what needs to be done to accommodate the concept of stimulus class to the data on multiple stimulus relations. First, we must be willing to use the term *class* to indicate the reliable selection of one stimulus given another stimulus, because the classes that result need have none of the defining features of equivalence classes (e.g., transitivity). With this use of the term any reliable matching-to-sample result is indicative of a class by definition: The overall patterns of stimulus relations are thereby merely equivalence relations under contextual control. Thus, if the subject selects C3 given A1 and OPPOSITE, the subject is not relating the two as opposite (to agree to that is to overthrow the primacy of classes in the analysis of stimulus relations). Rather, the subject is putting C3 and A1 in a class under the control of an OPPOSITE contextual cue.

Second, the *pattern* of contextual control need not itself be explained. For example, the results of Steele and Hayes (1991) show that OPPOSITE cues functioned in the following way: Stimulus pairs selected in the presence of OPPOSITE that were an odd number of nodes away are now selected (are in a class) given SAME, and stimulus pairs selected in the presence of OPPOSITE that were an even number of nodes away are selected (are in a class) given OPPOSITE. How can OPPOSITE acquire this ability to organize classes in this way merely because subjects are pretrained to pick formally opposite stimuli in the presence of it? Sidman does not provide an account, but if contextual control over an innate equivalence process is learned (Sidman, 1994; see Barnes, 1994, p. 94), presumably he would have to appeal to a history with such contextual cues and with the pattern of results they establish. For example, individuals would have to learn the relations whereby if Stimulus A is more than Stimulus B, then B is less than A. But how would this be learned? First, it would seemingly have to

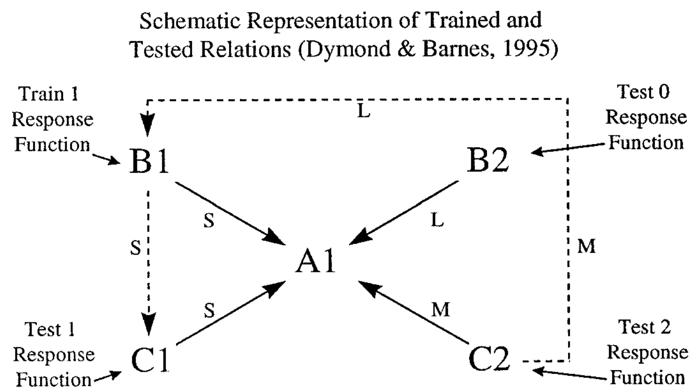

Fig. 1. Schematic representations of the most important of the trained (solid lines) and tested (dashed lines) relations in the Dymond and Barnes (1995) study. S, M, and L indicate the arbitrarily applicable relations of sameness, more than, and less than. The relational network from the Dymond and Barnes study also shows that a one-response function was trained using the B1 stimulus, and tests examined the transformation of the trained self-discrimination response function in accordance with the relations of sameness (C1, one response), more than (C2, two responses), and less than (B2, no response) (adapted from Dymond & Barnes, 1995; copyright the Society for the Experimental Analysis of Behavior, Inc., reprinted by permission).

be learned through the same type of history that, according to relational frame theory, is necessary for establishing multiple stimulus relations. Second, this learning history would have to establish cues that would have different functions in different parts of a stimulus network (e.g., more than/A $\rightarrow$ B is correct, but more than/B $\rightarrow$ A is incorrect). These functions are themselves difficult to interpret in class terms, and thus the overall pattern of contextual control still must be accounted for. Merely moving the issue of multiple stimulus relations to a vague appeal to contextual control is not an advance.

The limits of the concept of stimulus class in explaining the results of multiple stimulus relations are revealed even more clearly if we take the additional step of examining how stimulus functions transfer through these multiple stimulus relations. This was done in a study by Dymond and Barnes (1995), who used procedures similar to those of Steele and Hayes (1991) to first train control by the relations of same, more than, and less than with nonarbitrary stimulus sets (e.g., subjects were trained to choose a two-star comparison in the presence of a three-star sample given the LESS THAN cue). When the subjects had successfully completed the pretraining, they were then trained in six arbitrarily applicable relations using the three contextual cues. The four critical relations were SAME/A1-B1, SAME/A1-C1, LESS THAN/A1-B2, and MORE THAN/A1-C2. The subjects were then tested for seven derived relations, the following three relations being the most important: SAME/B1-C1, MORE THAN/B1-C2, and LESS THAN/B1-B2 (see Figure 1, upper section).

Three response patterns were then shaped via a complex schedule of reinforcement: (a) no response, (b) one response only, and (c) two responses only. The subjects were also trained to pick different stimuli given the response patterns they had been producing, rather than given particular stimuli as samples. Dymond and Barnes (1995) predicted that if choosing Stimulus B1 after making one response was reinforced, a subject, without further training, may then choose (a) C1 following one response (i.e., C1 acquires the same function as B1), (b) B2 following no response (i.e., B2 acquires a response function that is less than the B1 function), and (c) C2 following two responses (i.e., C2 acquires a response function that is more than the B1 function; see Figure 1, upper section). In fact, all 4 subjects demonstrated this predicted transformation of self-discrimination functions (see Dymond & Barnes, 1996, and Roche & Barnes, 1996, for related empirical research). The term *transformation,* rather than *transfer,* is necessary to describe the Dymond and Barnes data, because the explicitly trained one-response function of B1 transferred to C1, which was in an equivalence relation with B1, but not to B2 and C2, which were not. B2 and C2 did not acquire one-response functions. Instead, the one-response function of B1 was transformed in accordance with more than and less than relations between the stimuli, such that B2 and C2 acquired zero- and two-response functions, respectively.

It is difficult to predict, or even to describe, the test performances reported by Dymond and Barnes (1995) in terms of equivalence or other stimulus classes. Different functions emerged for C1, B2, and C2, and the functions seen were in accord with the derived relations between these stimuli and B1. The account in terms of relational frame theory is straightforward, but an account based on stimulus class seems to require that we invoke three separate classes (i.e., one for each function). These three cannot all be equivalence classes, however, because the functions did not change if the underlying relation was an equivalence relation but did change in the other two cases. Moreover, simply invoking three different classes would not allow us to predict the specific transformation of functions observed in the study (i.e., even if B1, B2, and C2 were members of three distinct classes, establishing a one-response function for B1 leaves the untrained functions of B2 and C2 unspecified). Perhaps the stimuli could all be in an equivalence class in which the function transformation was controlled, to some extent, by the nodal distances between the stimuli participating in the class (see Fields, Adams, & Verhave, 1993), but that would not explain the derived stimulus relations seen in matching to sample or the direction of the changed self-discrimination functions, because B2 and C2 were both removed by one node (i.e., A1) from the B1 stimulus (see Figure 1, upper section). Dymond and Barnes examined two further class-based accounts of their data, separable stimulus compounds and ordinal classes, and also found these to be inadequate (Dymond & Barnes, 1995, pp. 182–183).

The core of the problem that multiple stimulus relations present to a class-based account is this: If any relation between a stimulus pair is defined in terms of a contextually controlled equivalence class, the mathematical definition of equivalence in terms of reflexivity, symmetry, and transitivity must collapse, and with it the need for equivalence as a concept (see Barnes & Roche, 1996). Consider, for example, a subject who is trained to choose B in the presence of A given a MORE THAN context. Presumably this subject should not then choose, in the same context, A given B (i.e., A is in fact less than B) or A given A or B given B (a stimulus cannot be more than itself). In this particular example, therefore, we are left with neither symmetry nor reflexivity as defining properties of the subject's pattern of responding to the stimulus pair. If any two stimuli that go together, or are partitioned into a set, are members of a contextually controlled equivalence class, we are thereby left with no additional specific pattern of behavior that can be isolated as characteristic of an equivalence class. In an effort to retain *class* as the core outcome concept, and equivalence classes as its manifestation in the case of derived stimulus relations, the distinction between equivalence and other classes has to be undermined. We are left with the term *equivalence,* but the concept itself has broken down.

Evidence for this breakdown is accumulating. Equivalence researchers are suggesting new forms of equivalence classes (e.g., ordinal/sequential; see Green, Stromer, & Mackay, 1993). Sidman has backed away from such key points as his four- or five-term contingency analysis (Sidman, 1994, pp. 378–379) and stimulus selection as the basis for equivalence class formation (Sidman, 1994, p. 399). As we have tried to show above, Sidman's view of nonequivalence relations as contextually controlled equivalence classes (Sidman, 1994, p. 561) undermines his own set theory definition of equivalence in terms of reflexivity, symmetry, and transitivity. That leaves only the concept of partition or class standing intact in the traditional approach to equivalence, and that was a concept we had before equivalence arrived. We believe that this inconsistency and process of decomposition show a fundamental error: The refusal to go beyond "stimulus class" has hamstrung the analysis of derived stimulus relations.

Horne and Lowe's Answer: Naming and Stimulus Classes

In contrast to Sidman, Horne and Lowe (1996) present a much more elaborate view of stimulus equivalence, although it is one with considerably less empirical support. In agreement with relational frame theory, they see stimulus class formation as the result of operant activity, but in a major point of disagreement, the end result is still simply a stimulus class.

Lowe and Horne suggest that naming emerges, as a higher order behavioral relation, when listener and speaker behavior combine (Lowe & Horne, 1996, p. 315). In their article, they propose in great detail how a young child's interaction with the verbal community might establish and maintain generalized or higher order classes of listener and echoic behavior. These behavioral repertoires then combine, according to Horne and Lowe, to produce the higher order name relation. In their own words,

> When listener and echoic relations combine in the presence of particular objects or events, this creates the conditions for the emergence of a new response class of speaker behavior that is directly evoked by these objects and events. Thus, objects now give rise to speaking and then to listening, that is, reorienting to the objects, which in turn reevokes speaker behavior and so on. This closes the circle and establishes a functional unity of these three generalized classes of behavior. At this point the higher order name relation is established. . . . the first instances of this new unit are explicitly reinforced by caregivers. What is now reinforced, of course, is the behavior class as a whole. With each reinforced repetition of the name relation, perhaps as new object class members are encountered (e.g., a new dog, a new chair), naming as a functional higher order class is further strengthened. Thereafter, explicit reinforcement by caregivers for new name relations becomes less important as the automatic reinforcing consequences of naming things become the more potent source of control. (Lowe & Horne, 1996, pp. 317–318)

Having outlined how naming is established in the behavior of a young child, Horne and Lowe (1996) then attempt to use the concept of naming to explain the formation of stimulus classes. In particular, they suggest that the name relation helps to explain the formation of functional stimulus classes (pp. 204–206) and stimulus equivalence classes (e.g., p. 207). With regard to equivalence classes, Horne and Lowe suggest that naming may produce an equivalence class via common naming (pp. 215–218), via intraverbal naming (pp. 218–221), or via some other verbal behavior (pp. 221–222). The details of these explanations for the formation of equivalence classes are not important here. What matters is that in focusing on naming explanations for the formation of stimulus classes per se, Horne and Lowe have yet to provide an explanation for behavior that is not easily described in terms of stimulus classes alone. It is not clear, for example, why a named stimulus relation might operate as a stimulus relation merely because it is named.

Horne and Lowe were challenged on this very issue when they were asked to "explain the Steele and Hayes data using their approach" (Hayes, 1996, p. 311). They did not rise to the challenge other than to say that subjects "will have used verbal behavior (i.e., names and rules) to solve the problems posed" (Lowe & Horne, 1996, p. 333). Horne and Lowe apparently believe that the derivation of multiple stimulus relations requires not just naming but also rule governance, a level of verbal ability that extends well beyond the name relation (Horne & Lowe, 1996, pp. 212–213).

This claim by Horne and Lowe is hard to evaluate, especially because rule governance is even less well understood, both empirically and conceptually, than derived stimulus relations. But some form of empirical evaluation may be possible over the short term, because Horne and Lowe seem to be invoking forms of verbal control that are fairly elaborate. If complex multiple stimulus relations can be readily established in very young children, a simpler explanation may be warranted.[1]

If Horne and Lowe's account is to be parsimonious, they must explain the derivation of multiple stimulus relations using naming only, and that they have not done. It is not enough merely to explain derived stimulus relations by a reference to verbal behavior. The precise verbal performances needed, and their source, must be specified. If the performance is explained by rules, Horne and Lowe must specify exactly how naming gives rise to rule governance, and then how rule governance gives rise to the derivation

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[1] Vaughan, M., & Barnes, D. (1994, November). *Children's perception of pain and bullying: A relational-frame interpretation.* Paper presented at the Annual Conference of the Psychological Society of Ireland, Kilarney, Ireland.

of multiple stimulus relations. If this explanation is not cast in terms applicable to very young children, and multiple stimulus relations are then shown in that population (see footnote 1), Horne and Lowe's account is disconfirmed.

We cannot see how naming alone—as described in Horne and Lowe's (1996) account—can produce multiple stimulus relations, in part because the end product of naming is merely a stimulus class. All of our objections in the previous section about the limitations of that concept as the explanation for multiple stimulus relations apply with equal force to classes formed via naming. We do not deny, of course, that subjects may name the relations involved, but in terms of relational frame theory this shows only that stimulus relations themselves can enter into a "frame of coordination" with a name. It does not show why named relations relate. In the same way that Sidman relies on contextual control to address the issue, Horne and Lowe rely on naming, but both fail to deal with relational operants directly and in detail, or to show why multiple relational operants cannot be learned the way most operants are learned.

Relational frame theory accounts for all of the existing naming data quite readily and without modification. It does so by allowing for the acquisition of a variety of relational operants, not just one (in the case of Horne and Lowe) or none (in the case of Sidman). When stimulus relation is the core concept, equivalence classes can sometimes result (e.g., through frames of coordination), but sometimes they do not.

Developing Methods for Examining Stimulus Relations

The matching-to-sample procedure emphasizes class formation as the product because the results can always be analyzed as a matter of partitioning stimuli. The concept of stimulus relation is built into basic behavior analysis (in concepts like *contingency,* for instance) but the methods that exist for the assessment of nonarbitrary stimulus relations have not been adequately applied to those that are abstracted and brought under contextual control.

Some methodological advances might be made by examining these methods. For example, classical conditioning is a kind of stimulus relation, but respondent-type training procedures have only been applied to equivalence classes quite recently (Barnes, Smeets, & Leader, 1996; Leader, Barnes, & Smeets, 1996; Smeets, Leader, & Barnes, 1997). The basic procedure involves presenting an arbitrary Stimulus A that reliably predicts the appearance of a second arbitrary Stimulus B (i.e., A $\rightarrow$ B; note that A and B are never presented simultaneously). At least two trial types may be trained initially (e.g., A1 $\rightarrow$ B1 and A2 $\rightarrow$ B2). Following sufficient exposure to this respondent training procedure, subjects (both adults and children as young as 5 years old) presented with these stimuli in a matching-to-sample procedure normally pick Stimulus A1 (as a comparison) in the presence of Stimulus B1 (as a sample); similarly, they pick Stimulus B2 given A2. In effect, having been exposed to A $\rightarrow$ B respondent training, adults and children respond in accordance with the B-A symmetry relation. Furthermore, when the same subjects are exposed to A $\rightarrow$ B $\rightarrow$ C respondent training, they normally respond in accordance with C-A equivalence relations on a matching-to-sample test.

These findings show that "picking" is not necessary when training for equivalence class formation, but they are only a first step, because they are designed to examine only equivalence classes; furthermore, a matching-to-sample (equivalence) test was used to examine the effects of the training. But this same approach can be expanded into a method designed to assess multiple stimulus relations. We believe this is worth an extended discussion, because the failure to go beyond the class concept seems so much determined by the methodological narrowness of the entire area.

The Relational Evaluation Procedure and the Derived Stimulus Relations of Before and After

The new method described here is called the *relational evaluation procedure* because it was designed to allow subjects to report on, or evaluate, the stimulus relation or relations that are presented to them on a given task. This present example is focused on the derived stimulus relations of before and after, but a similar approach can be used for vir-

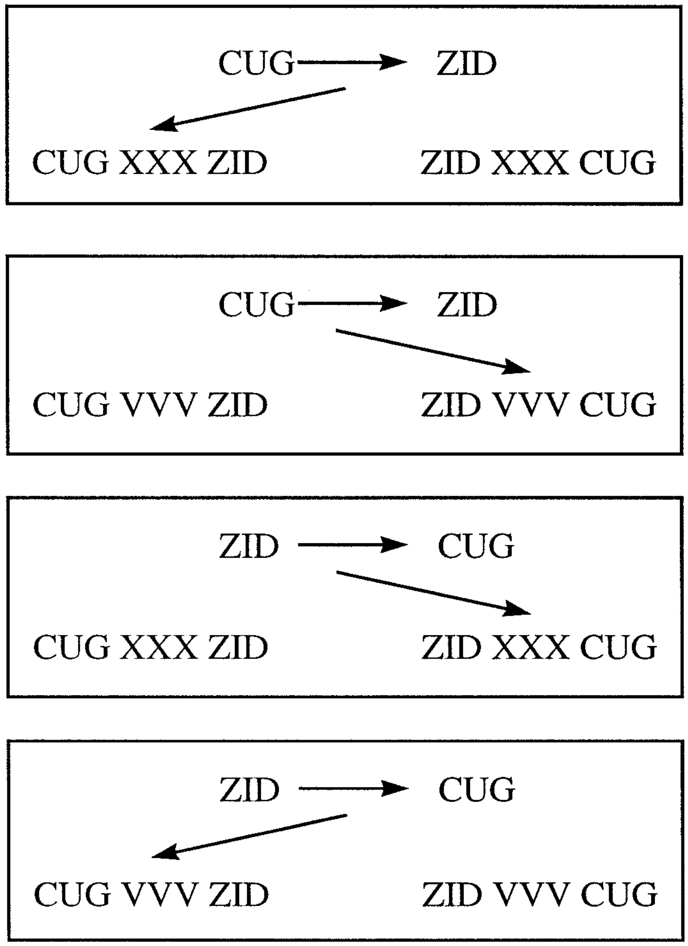

Fig. 2. Schematic representation of the four tasks used to establish contextual control by the before and after cues (see text for details).

tually any relation. The core of the method is this: Establish a procedure in which subjects may confirm or deny the applicability of particular stimulus relations to sets of stimuli. In so doing, the focus shifts from stimulus partitioning and picking (with its class connotations) to relational specification and evaluation.

Before/after training. On each trial, a nonsense syllable (e.g., CUG) appears in the center of a computer screen for 1 s, disappears for 1 s, and is followed by a second syllable (e.g., ZID) for 1 s. The presentation of these two stimuli, one after the other, functions as a sample stimulus, and following a further 1-s delay, two three-element comparison stimuli appear on the screen, one in the lower left corner and the other in the lower right corner. Reading from left to right, both comparisons (which we will term here *statements*) contain the nonsense syllable just displayed (e.g., CUG), an arbitrary relational contextual cue (e.g., XXX or VVV), and the other nonsense syllable just displayed (e.g., ZID). Subjects must select one of the two comparison statements, and are then given feedback.

Examples of four such tasks are shown in Figure 2. On one of the trials in which CUG was shown before ZID in the first part of the trial, for instance, "CUG XXX ZID" is correct but "ZID XXX CUG" is not, and "ZID VVV CUG" is correct but "CUG VVV ZID" is not. In this fashion, XXX is treated as functionally equivalent to "before" and VVV to "after." What is critical for our present purposes is that, like statements in natural language, the

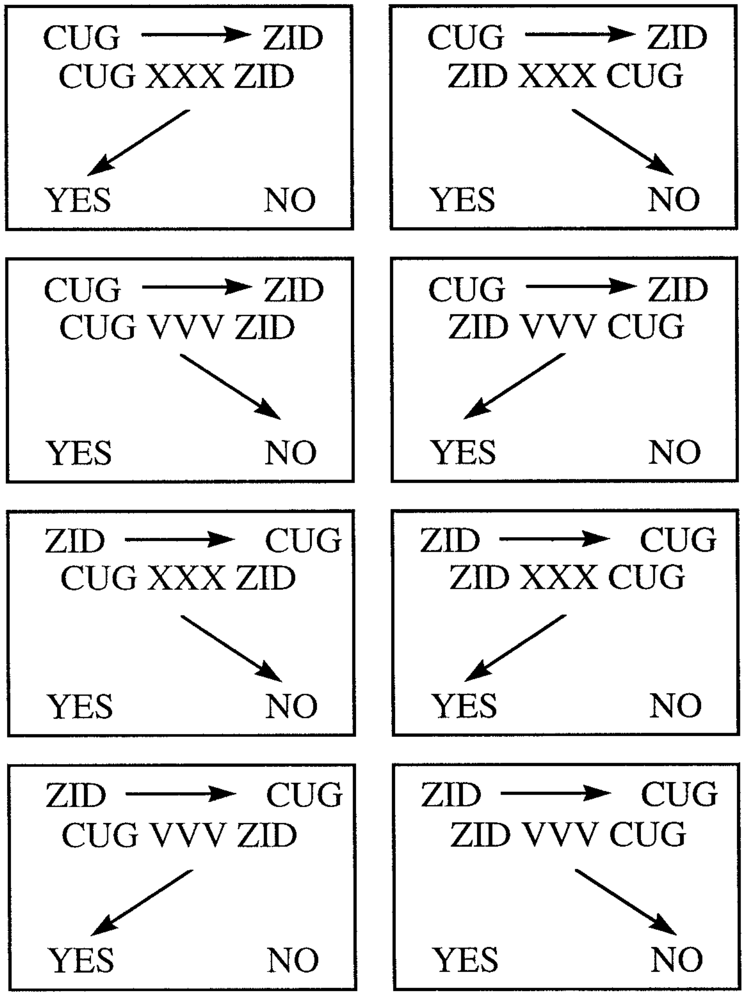

Fig. 3. Schematic representation of the eight tasks used to train "yes" and "no" functions in combination with the before and after cues (see text for details). During a subsequent test phase (no feedback) the same eight tasks were used, but the CUG and ZID stimuli were replaced with novel nonsense syllables. Note that in the actual procedure "yes" and "no" are arbitrary stimuli, not known words.

correctness of the items cannot be distinguished on the basis of the two nonsense syllables or on the basis of the relational contextual cue, but only on the relation among all of these to some state of affairs.

Evaluation of statements. Once the meaning of the relational contextual cue is established, these statements can be affirmed or denied, rather than picked from a set of comparison statements (see Figure 3). For example, if ZID is shown before CUG, the statement "CUG XXX ZID" is incorrect, and reinforcers are contingent upon selection of one of two novel nonsense syllables (that is thus functionally equivalent to "no"; on other trials the "yes" stimulus is selected, as is shown in Figure 3).

Once such a procedure is established, subjects can be trained and tested on entirely new sets of stimulus relations using the "yes" and "no" stimuli. As in natural language, stimulus relations can even be trained without any explicit overt responding at all (e.g., "YES" TUH VVV FRE might establish that FRE came first). Any relational stimulus can be similarly trained, provided only that pretraining exemplars can be provided. Note also that this procedure does not require any instructions that would preclude its use with nonhumans.

We have only recently begun working with the relational evaluation procedure, but our preliminary research has shown that subjects can produce such performances with ease.[2] The flexibility of the procedure can lead quickly to remarkably complex behavior. On one typical trial, for example, the sample stimulus consists of the following string of characters, ''CUG XXX VEK XXX ZID XXX YIM XXX DAX,'' which appears above the string ''CUG XXX YIM VVV VEK'' (XXX and VVV have previously been established as before and after). The subject is required to choose between the ''yes'' and ''no'' nonsense syllables to indicate whether the lower string may be derived from the top string. In this case, the correct choice is ''yes.''

Our point in reviewing the relational evaluation procedure is to show how much our current methods emphasize stimulus classes over stimulus relations, and to give an example of what methods focused on stimulus relations might look like. It is extremely difficult to think in terms of stimulus classes with the resulting relational performances. Consider, for example, the following test performance: C $\rightarrow$ D/D XXX C, pick ''no.'' When the subject chooses the ''no'' nonsense syllable, should we define it as participating in an equivalence class with D before C? If so, then its participation in this class must be under a complex form of contextual control, because on other tasks D before C controls picking ''yes,'' and on yet other tasks D after C and C after D also control picking ''no.''

We are not suggesting here that a class-based account could not be constructed for these data, but we question the functional utility of doing so, particularly as more complex tasks with multiple relations are used (as indeed, we would argue, is occurring this moment as readers read this material: We would argue that the reader is deriving stimulus relations among verbal classes, not merely partitioning stimuli into classes). In contrast to a class-based account, however, consider the relative ease with which the same data may be interpreted in terms of multiple stimulus relations. From this perspective, the subject is presented, on any given trial, with a relational network (e.g., the statement) that is to be compared to what is known about the network elsewhere. Thus, when a subject chooses ''no'' when presented with C $\rightarrow$ D/C VVV D, the response is controlled by the nonarbitrary temporal relation C before D, the arbitrarily applicable relation VVV being applied to C and D, and the relation of distinction that obtains between the two (i.e., the nonarbitrary relation C before D is different than the arbitrarily specified C after D). This simple formulation in terms of a relational network may be applied with relative ease to any of the tasks outlined above, or to their more complex forms. It is hard to think of performances on the relational evaluation procedure in simple partitioning or class terms, because what distinguishes correct and incorrect responses is the applicability of stimulus relations, not mere stimulus partitions.

[2] Hegarty, N., & Barnes, D. (1996). *Responding in accordance with the relational frame of before and after: An experimental analysis.* Paper presented at the annual conference of the Experimental Analysis of Behaviour Group, London.

Conclusion

Relational operants are classes of operant behavior, but their results are abstracted and arbitrarily applicable stimulus relations, not necessarily stimulus classes. The concept of stimulus class, which has an important place in behavior analysis, needs to be added to, not thrown over. It seems better to make the needed conceptual and methodological modifications than to deal with the narrowness, decomposition, and distortion that is resulting from an attempt to hold to the concept of stimulus class as the single organizing principle and result in the area of derived stimulus relations.

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THE ROLE OF JOINT CONTROL IN THE DEVELOPMENT OF NAMING

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In my earlier comments (Lowenkron, 1996), I pointed out that Horne and Lowe's (1996) account of the naming relation seems to be deficient in explaining how novel stimuli come to be selected in response to their names after the names are learned as responses to the stimuli. I also suggested that this deficiency could be remedied, and several strengths could be gained, by appreciating the role *joint control* plays within the naming relation. Lowe and Horne (1996, p. 318), however, assert that applying the joint control account to the naming relation involves two problems: first, that it engenders an anachronism with respect to the order in which the

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